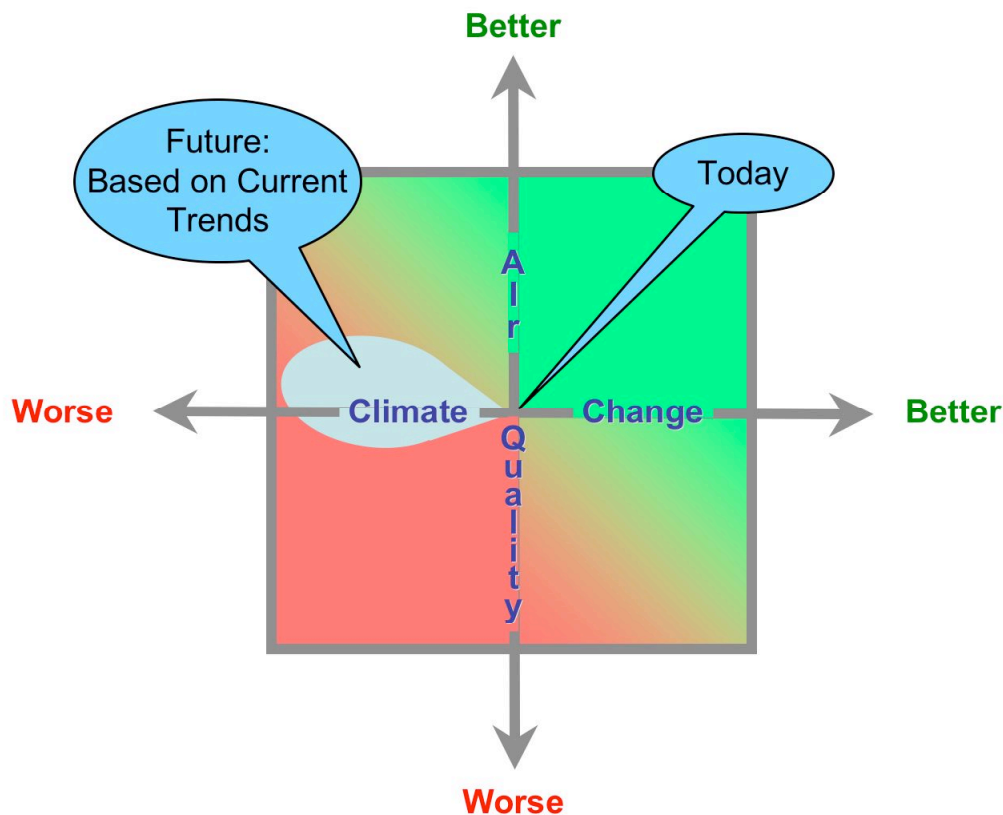




Earth System Research Laboratory
SCIENCE, SERVICE & STEWARDSHIP

2010 CalNex Science Issues and Assets

Science to Support Decisions



NOAA Study in
California

May-July 2010

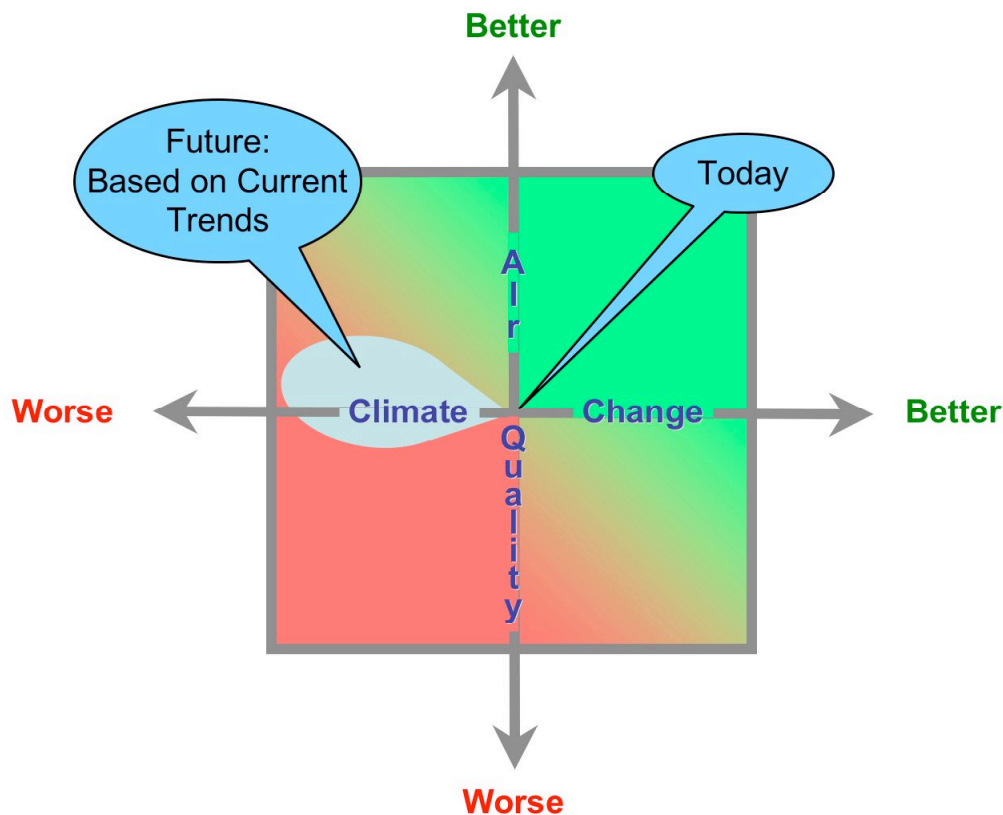
In collaboration with
CARB

Tom Ryerson
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2010 CalNex Science Issues and Assets

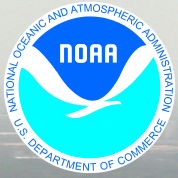
Science to Support Decisions



Science at the Nexus of Climate Change and Air Quality

1) Two problems are managed in separate ways

2) Sources and Processes for these 2 issues are the same (nearly).



NOAA Focus for CalNex 2010

Combined Climate Change and Air Quality Focus

- Emissions Quantification - Greenhouse Gases and Precursors of O_3 and Aerosols, Increasing Importance of Biomass Burning
- Chemical Transformation - O_3 and Aerosols, Day and Night, Gas-Phase and Heterogeneous
- Transport and Mixing - Intercontinental, Inter- and Intra-state, Boundary Layer/Free Troposphere
- Aerosol Properties and Radiative Effects - Direct Radiative Forcing, Cloud-Aerosol Interactions
- Model Development - Diagnostic Evaluation of Forecast Models, Development of Regional Climate Models



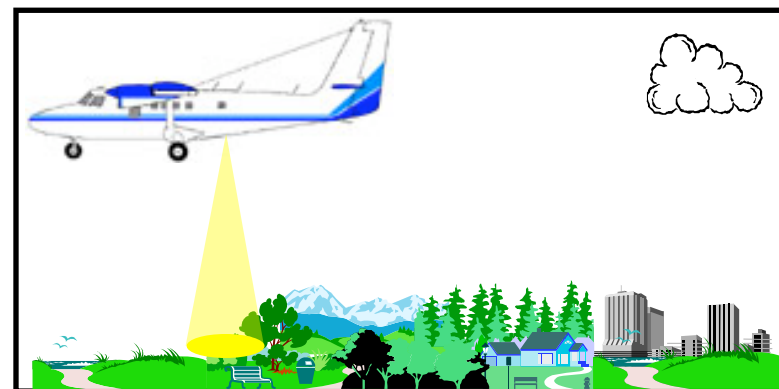
NOAA's Assets

NOAA WP-3D Aircraft - in situ gas-phase, aerosol and cloud measurements, emissions testing (precursors and GHG), regional and inter-regional transport, day/night O_3 /PM chemistry, aerosol and cloud properties.

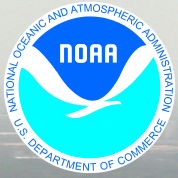


NOAA R/V Ronald H. Brown - in situ and remote sensing for investigating marine chemistry, marine and coastal emissions, land/bay/sea breeze recirculation, aerosol-physics, -chemistry, -optics and satellite validation.

NOAA LIDAR Aircraft - regional distribution of O_3 and PM, urban and power plant plume studies, regional and inter-regional transport, boundary layer evolution and variability.



Collaborate with Others on fielding Ground-based Remote and In Situ Instrumentation



Other CalNex Platforms

- CIRPAS Twin Otter – SOA Formation (Seinfeld)
- Los Angeles Supersite – SOA Formation and nighttime chemistry (Jimenez, Stutz, de Gouw)
- Central Valley Supersite – Agricultural emissions and ozone formation (Cohen, Goldstein, Wennberg, Brune, Thornton, Keutsch)
- Trinidad Head ground site – Greenhouse gases, ozone sondes (NOAA GMD)
- WGC Tower – Greenhouse gases (NOAA GMD, Fischer)
- Profiler Network – 3-Dimensional wind fields (NOAA PSD)
- Satellites – NO_x emissions (NOAA CSD)

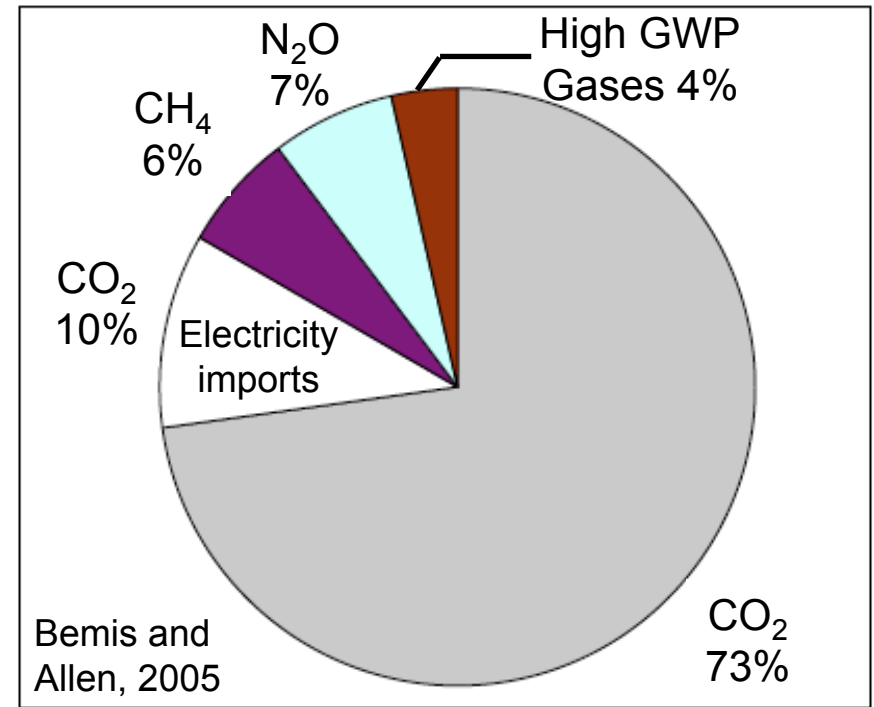
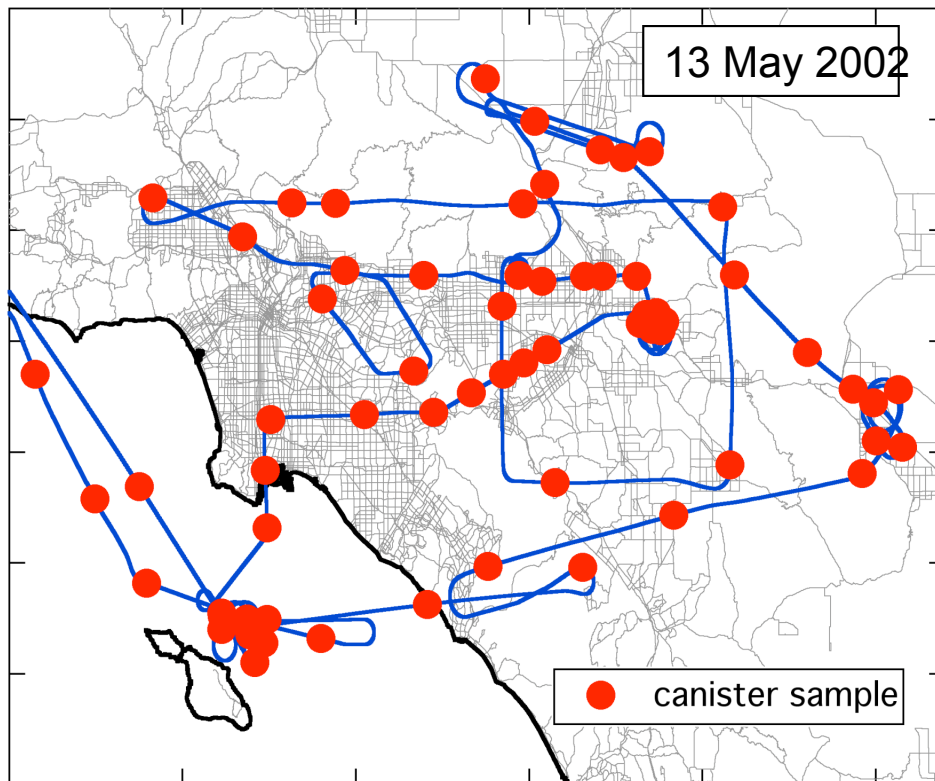


Emissions Quantification

Improved inventories are essential for predictive capability

Non-CO₂ GHG Emissions

- What can measurements tell us?



Global warming potential of greenhouse gases.

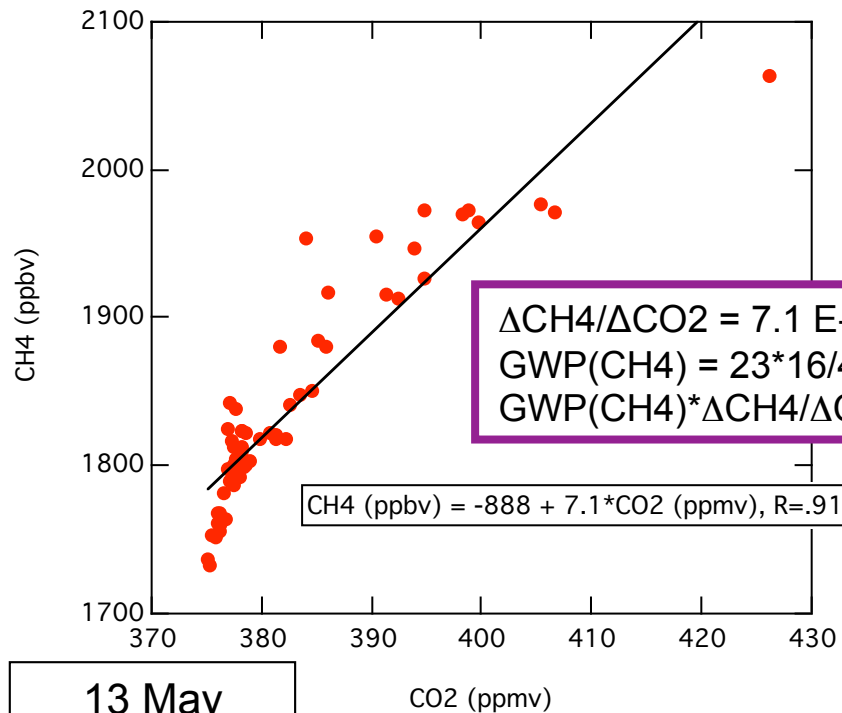
Gas	GWP	MW
CO ₂	1	44
CH ₄	23	16
HFC-134a	1300	102



Emissions Quantification

Improved inventories are essential for predictive capability

Non-CO₂ GHG Emissions



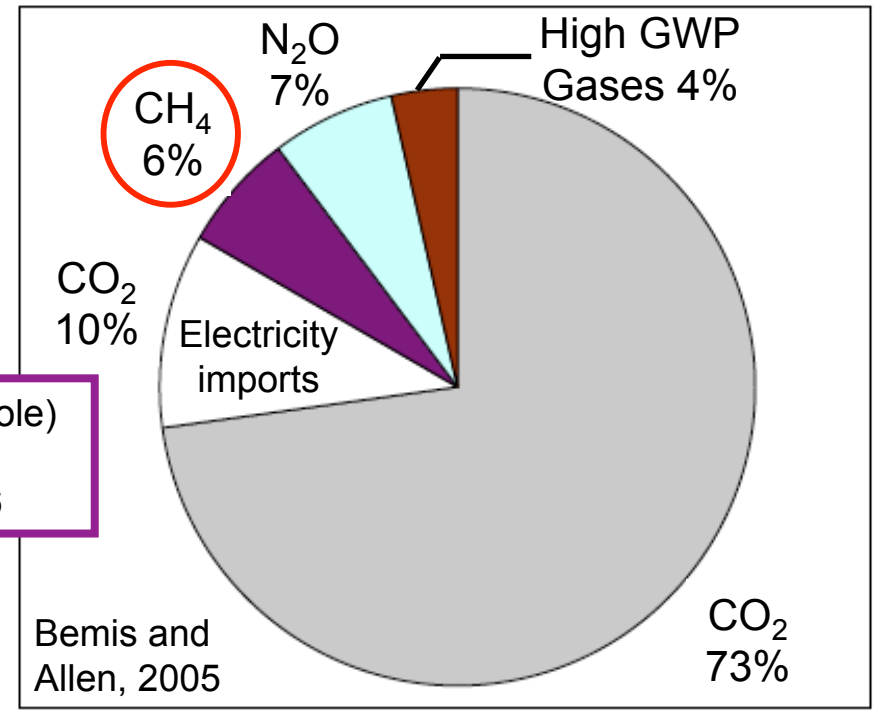
13 May
2002 WP-3D
flight

Los Angeles

2010: Provide more extensive data

- Spatial variability
- Agricultural contribution

Analysis by Mr. Trainer



California greenhouse gas emissions

Global warming potential of greenhouse gases.

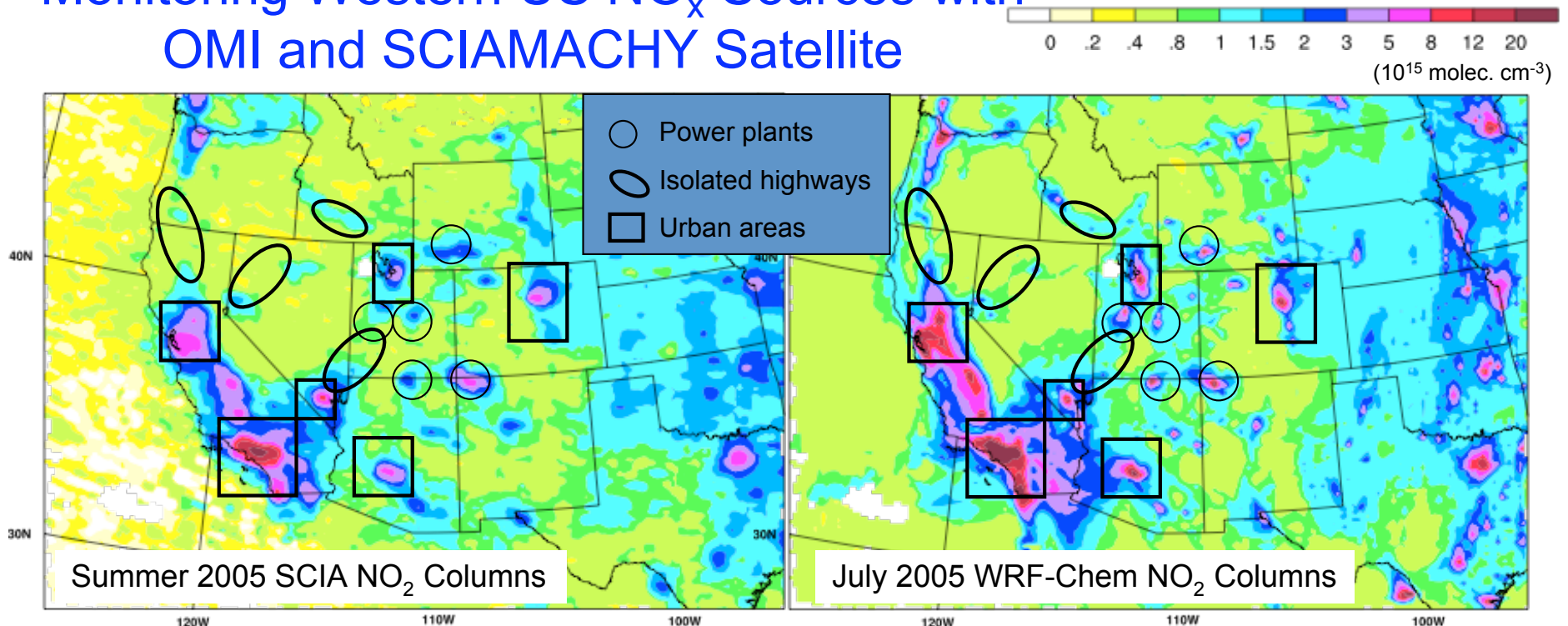
Gas	GWP	MW
CO ₂	1	44
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Emissions Quantification

Improved inventories are essential for predictive capability

Monitoring Western US NO_x Sources with OMI and SCIAMACHY Satellite



SCIAMACHY Data:

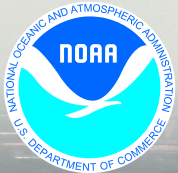
- horizontal resolution: $60 \times 30 \text{ km}^2$
- samples entire globe every 3 days at ~10:30 local time

Analysis by ESRL/CSD,
Univ. Bremen,
Germany

2010: Understand retrieval of point source signals.

Evaluate emission inventory on isolated interstate highways and urban areas.

Identify agricultural emissions?

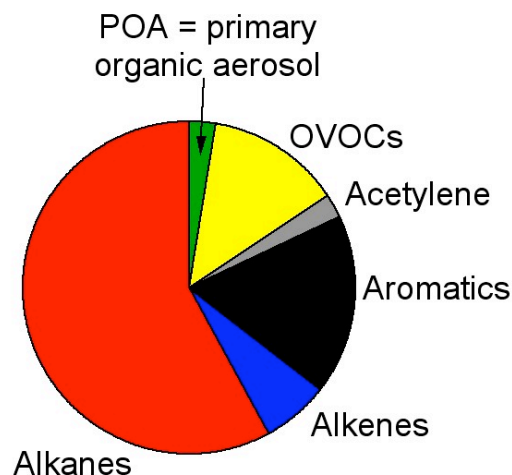


Chemical Transformation

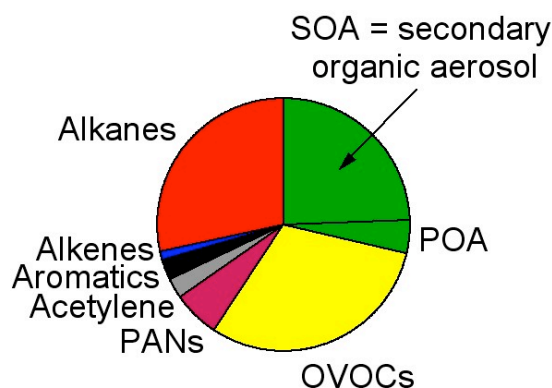
Aim to understand on a process level for predictive capability

Sources of Organic Aerosol in Polluted Air

At time of emission



After 2 days



In 2 days:

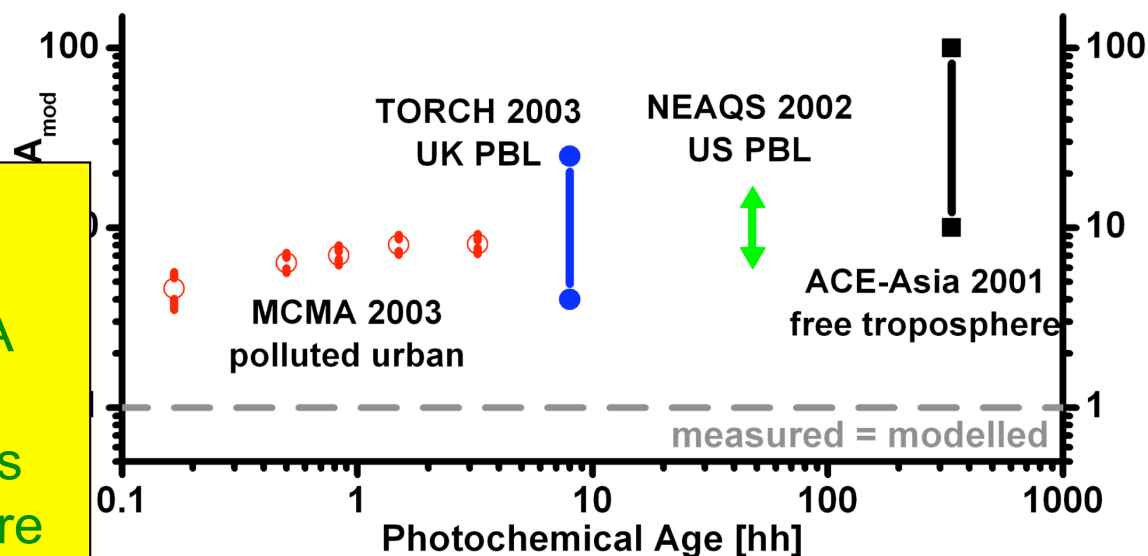
- Composition changes
- Pie shrinks: species not measured? Deposition?

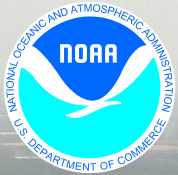
SOA growth >> expected:

➤ Semi-volatile precursors?

2010:

- Investigate early stages of SOA formation at central LA site.
- Coordinate with all platforms to build as complete a picture as possible





Chemical Transformation

Aim to understand on a process level for predictive capability

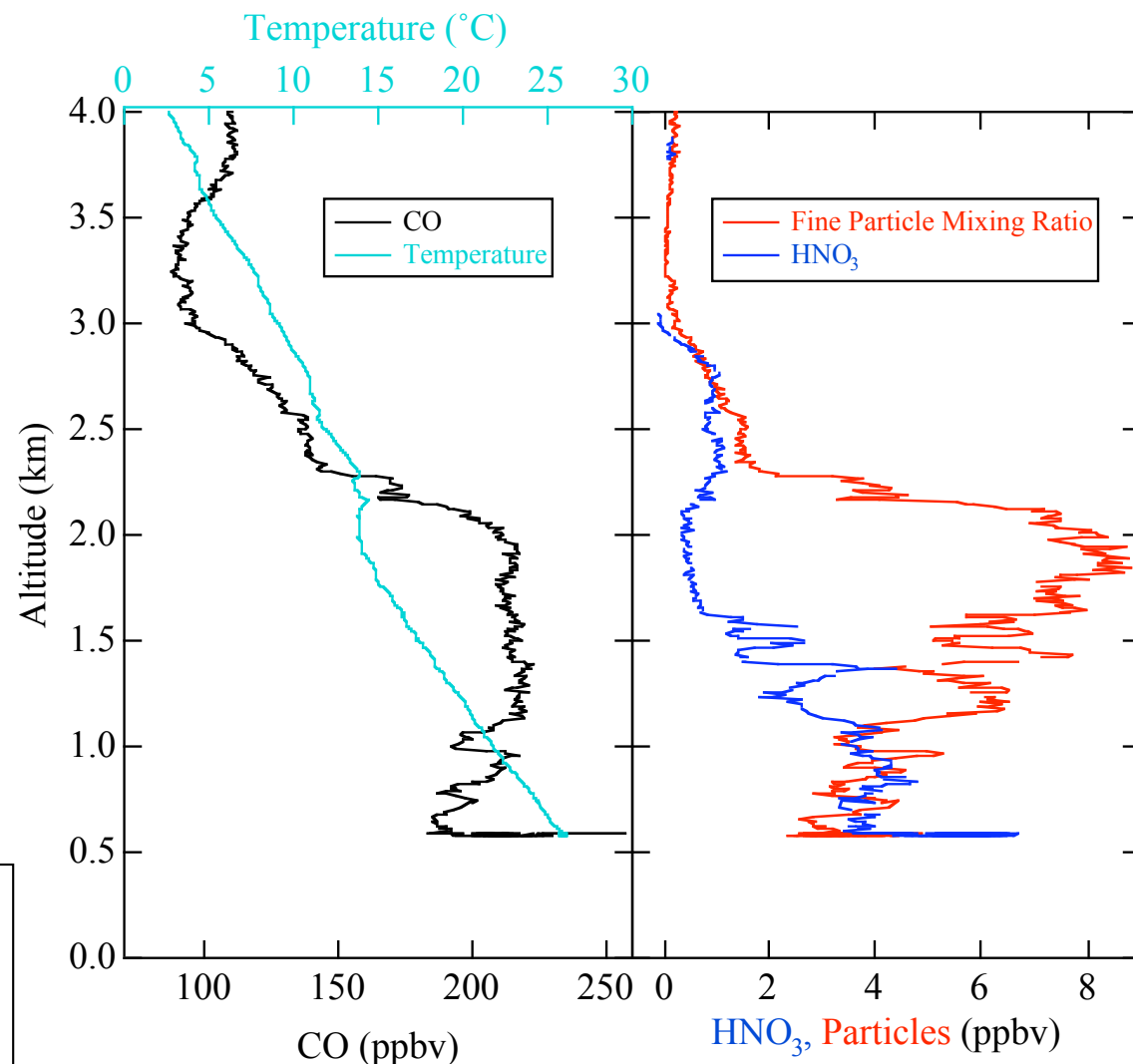
Aerosol Formation Mechanisms

Ammonium nitrate layers
observed within well-mixed
boundary layer over
California in May, 2002
from the NOAA WP-3D
aircraft.

Higher altitude = colder T =
more stable ammonium
nitrate = gas-to-particle
conversion

2010: Characterize more
fully with enhanced
particle composition
and precursor

measurements



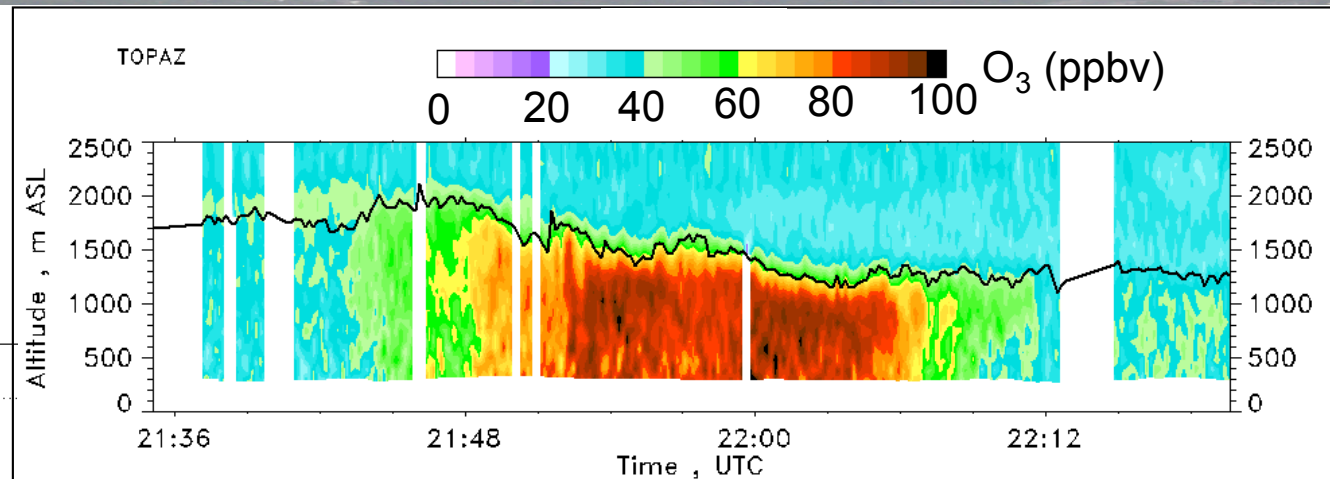
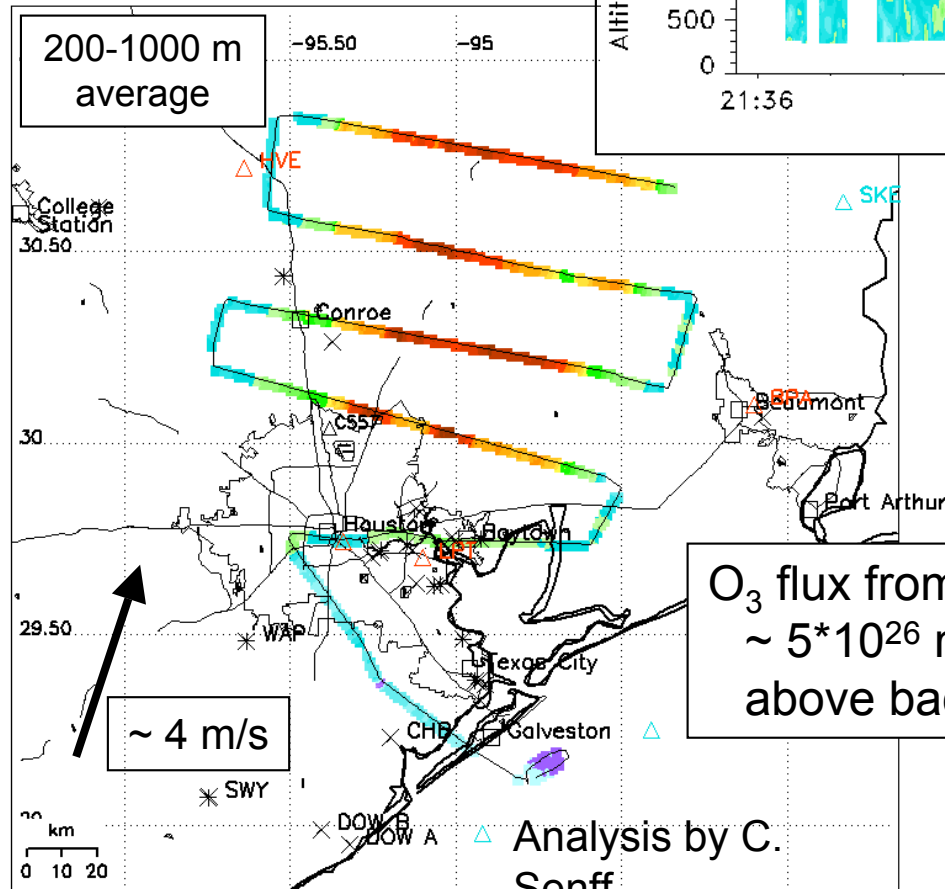
Neuman, J. A., et al., Variability in ammonium nitrate formation and nitric acid depletion with altitude and location over California, *J. Geophys. Res.*, 108(D17), doi:10.1029/2003JD003616, 2003.



Transport and Meteorology

Understanding is critical for characterizing O_3 and PM levels

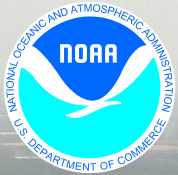
Characterization of O_3 and PM transport from urban



Cross section of Houston urban plume 50 km downwind

Airborne O_3 - aerosol lidar provides ideal tool

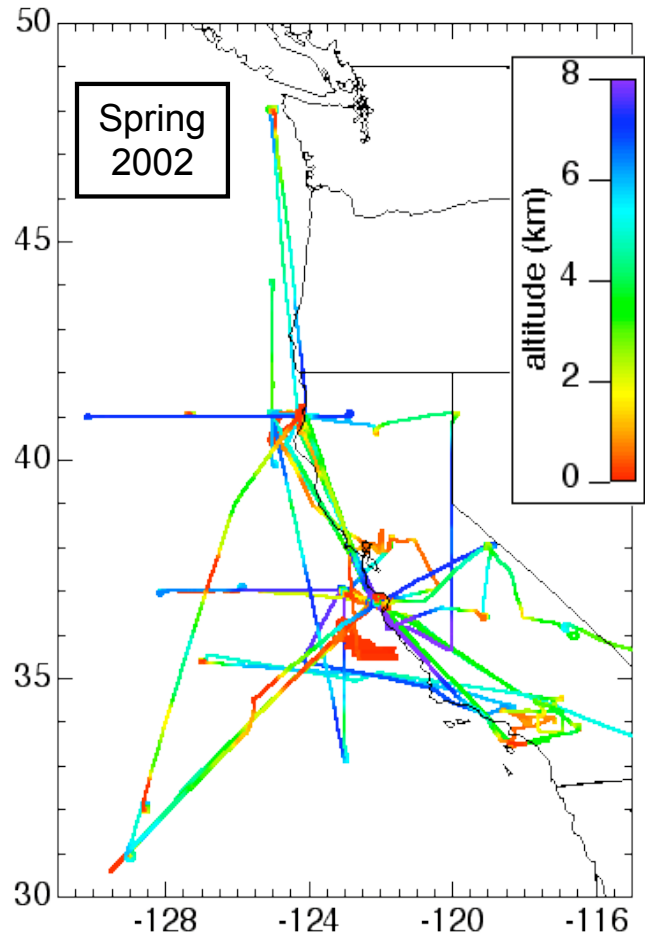
2010: Characterize plumes from California urban areas.



Transport and Mixing

Understanding is critical for characterizing local O₃ and PM

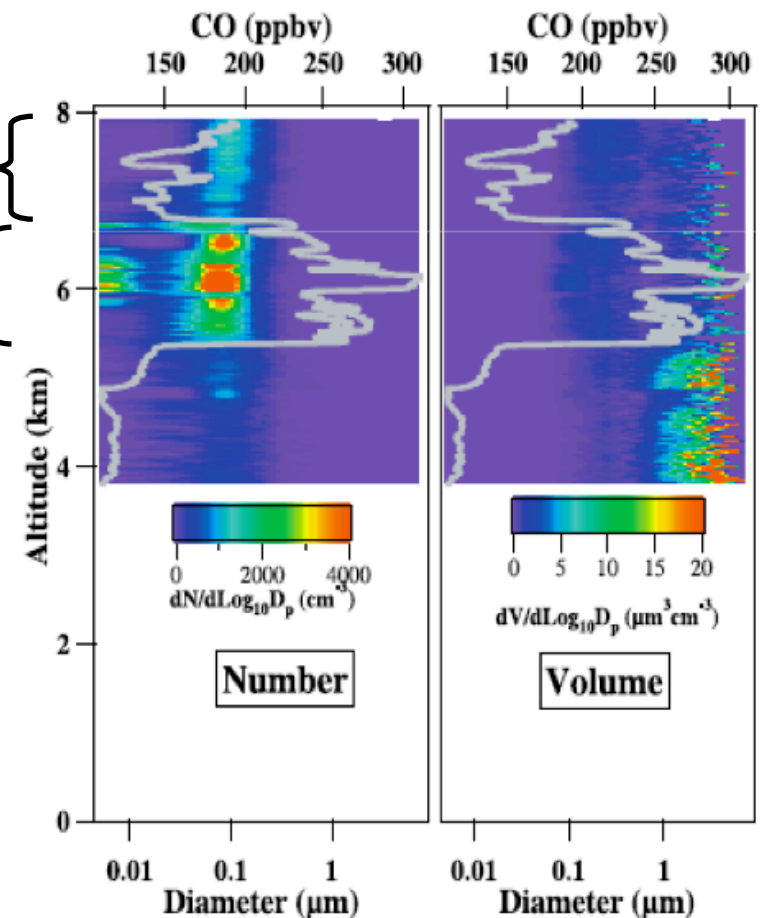
Intercontinental Transport



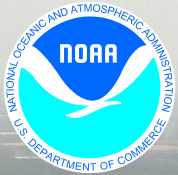
2010: Study in another season?

Layered emission plumes transported from Asia

Biomass burning aerosol layer
Industrial SO₄⁻ layer
Dust layer



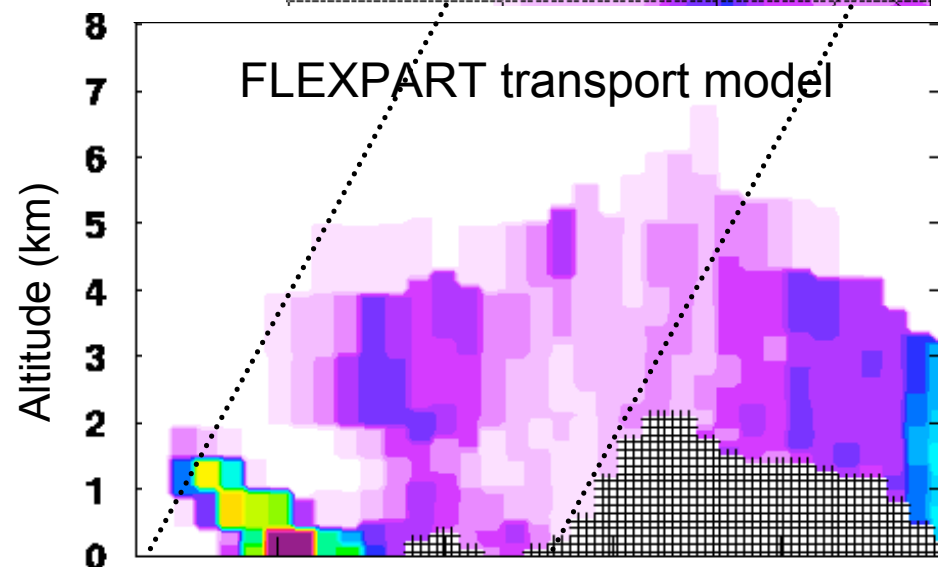
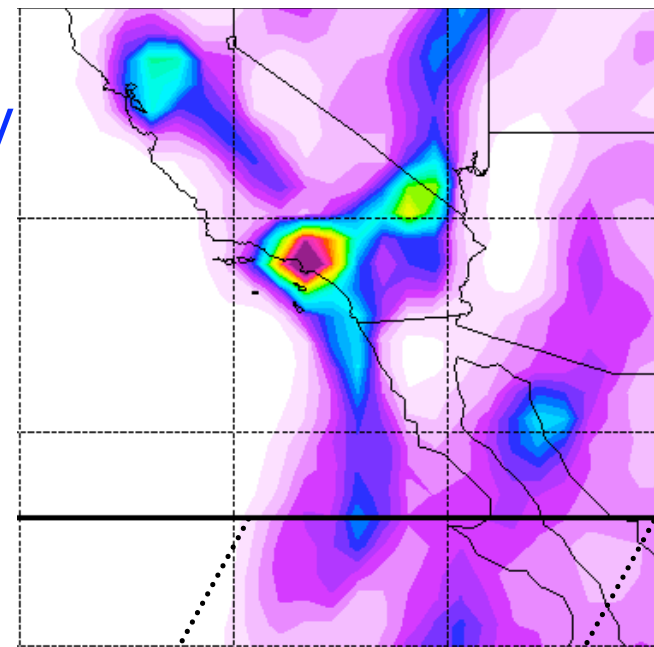
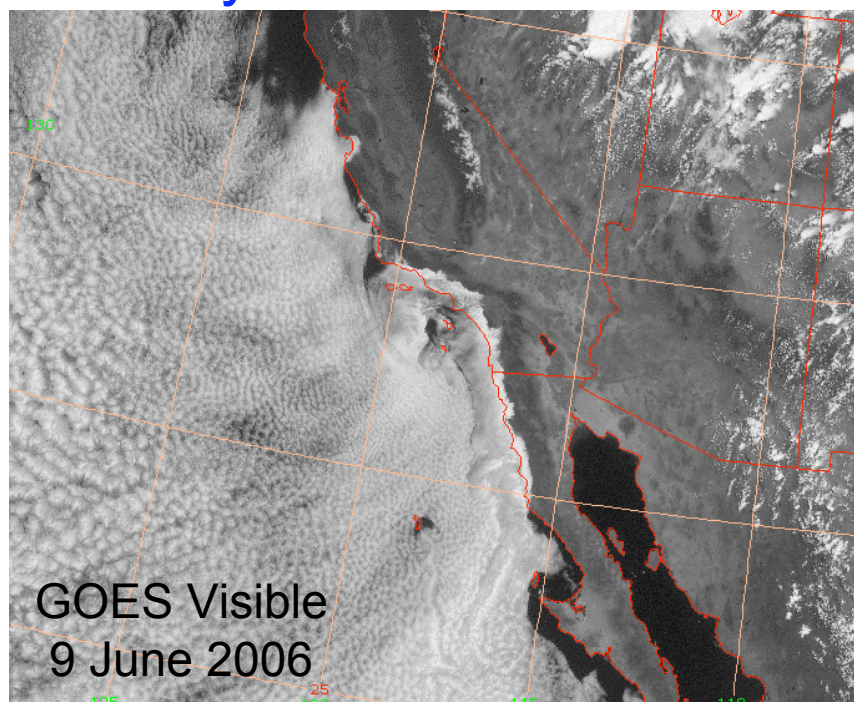
Brock, C. A., et al., Particle characteristics following cloud-modified transport from Asia to North America, *J. Geophys. Res.*, 109, D23S26, doi:10.1029/2003JD004198, 2004.

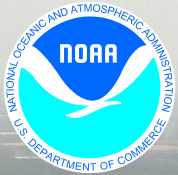


Aerosol Properties and Radiative Effects

Aim to reduce uncertainty of aerosol radiative forcing

Los Angeles plume advected into offshore stratus deck provides excellent laboratory to study aerosol indirect effect on

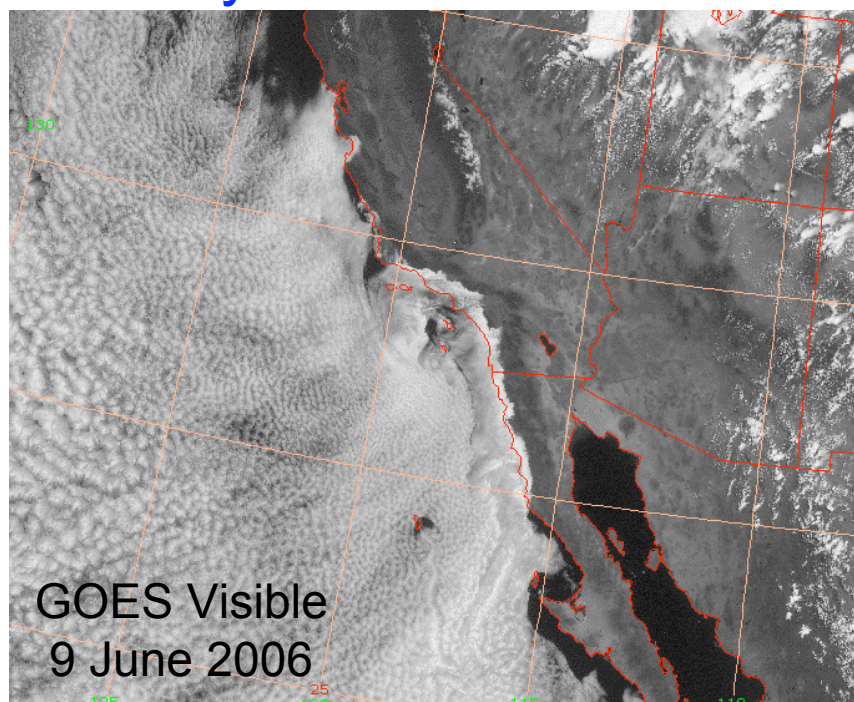




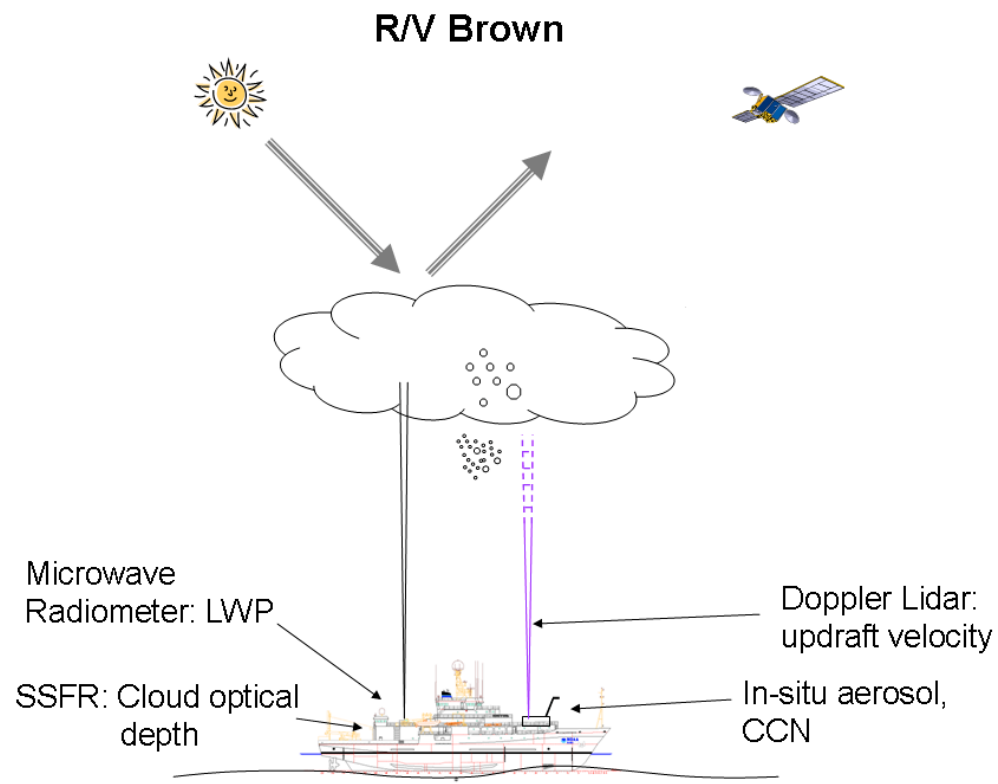
Aerosol Properties and Radiative Effects

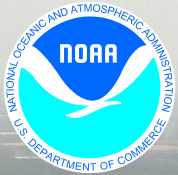
Aim to reduce uncertainty of aerosol radiative forcing

Los Angeles plume advected into offshore stratus deck provides excellent laboratory to study aerosol indirect effect on



2010: Contrast aerosol-cloud interactions with VOCALS results. Urban emission plume vs. smelter





Air Quality Forecast and Climate Models

Provide integrated picture and predictive capability

O₃ and PM Forecast Models

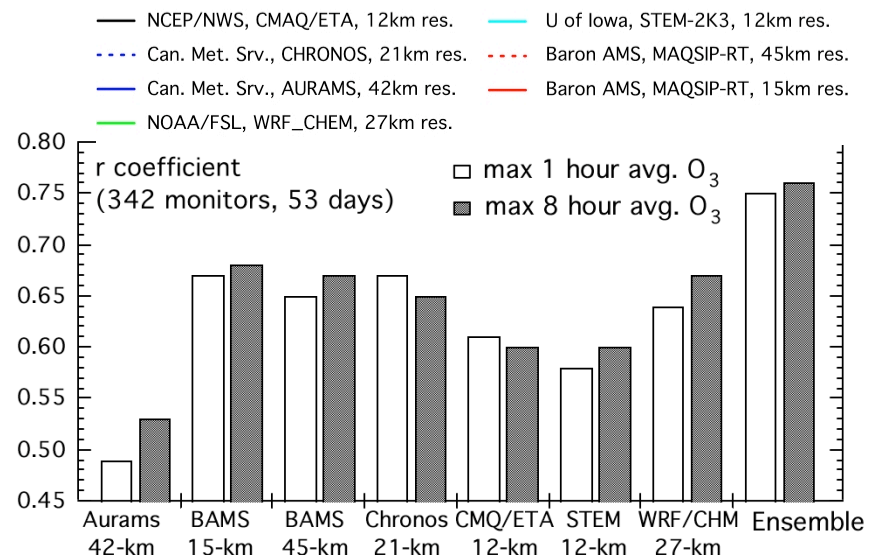
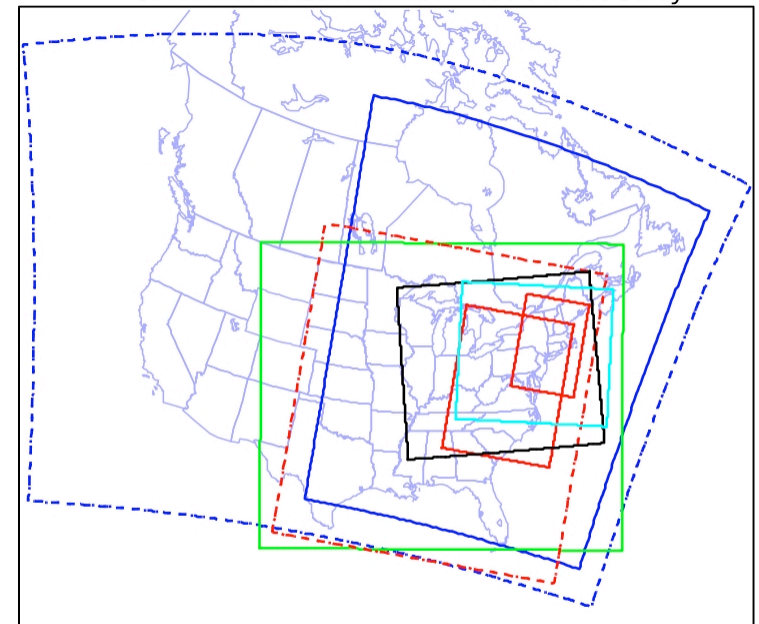
NOAA is to develop operational O₃ and PM forecasts for entire U.S. Currently, O₃ model is operational for eastern U.S.

PM model is under development

Regional Climate Models under Development

2010: Evaluate performance of models in California.

Seven Models Used in Ensemble Forecast Study

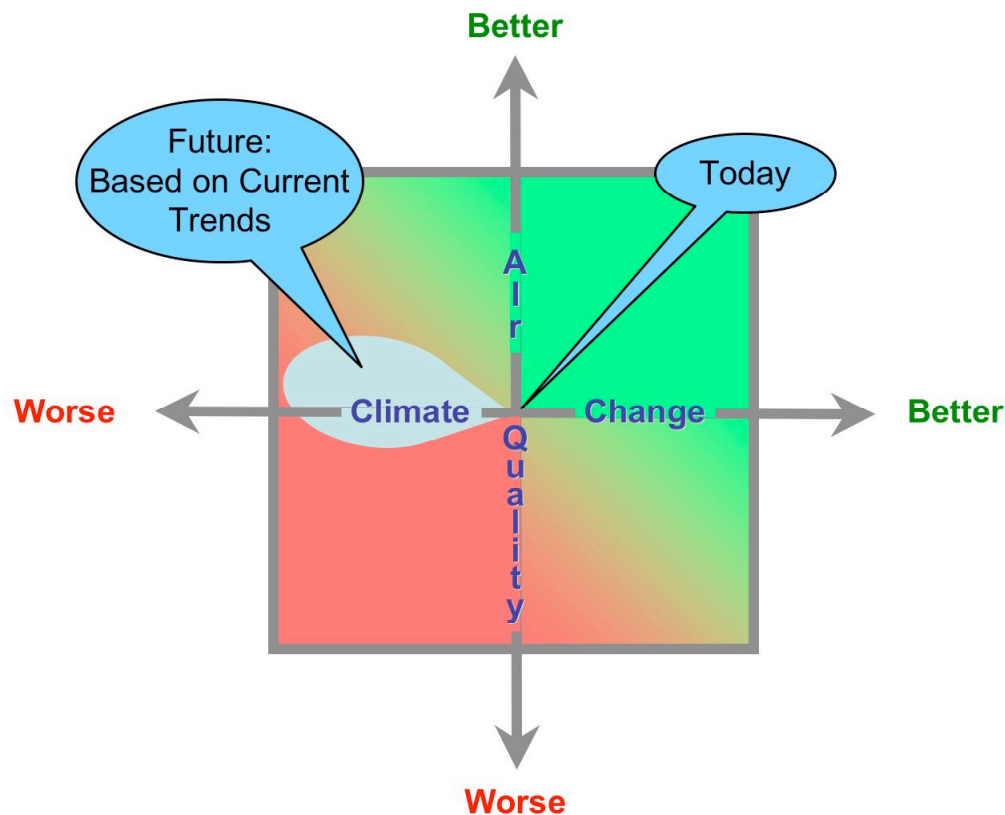




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